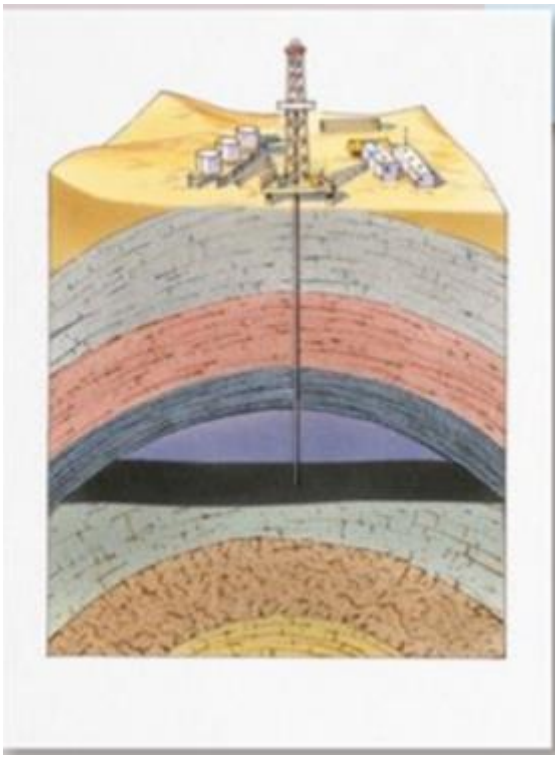


Formation Evaluation Product Development

DEFINITION AND SCOPE OF WORK

Monsoon Semester | GPD502 | 2024

Instructor: Partha Pratim Mandal | Assistant Professor | IIT(ISM) Dhanbad | partham@iitism.ac.in

Introduction

Hello everyone! Welcome to Formation evaluation tutorial. My self Partha Pratim Mandal, your course instructor. My specialization is experimental petrophysics, rock mechanics, geomechanical modelling, and rock physics. I will meet you over next 13 weeks during tutorial session. It is important to follow the tutorial session every week to understand the practical concept which will benefit you in long term for large scale data analysis/petrophysics/reservoir characterization/geomechanics/energy transition. I will be available for face-to-face discussion during and after the class. Either python programming, Matlab or R skills are essential to complete the task.

Product Development

As part of this unit learning, combined team members will work on the development of educational graphical user interfaces (GUI) for various types of well-log processing and interpretation.

This consists of the following four themes :

1. **GUI of basic petrophysics code**
2. **Advanced sonic log processing, visualization, and interpretation (GUI/Web)**
3. **NMR log visualization and processing (GUI/Web)**
4. **Image log visualization, processing and interpretation (GUI/Web)**

All the above themes consist of the following common sections: (i) Data Loading (ii) Data Processing and Well analysis (iii) Visualization and Interpretation and (iv) Interactive Graphical User Interface. A demo is visible by following this link https://github.com/andymcdgeo/las_explorer

1. Data Loading

This section will support loading well log files (e.g., **.las**, **.csv**, **.txt , .dlis**) as specific theme. Users can rename headers, change units, and receive error messages for unsupported formats.

2. Data Processing and Well Analysis

This section focuses on processing the loaded data, including handling missing values, performing key calculations, and evaluating relevant well log properties based on the specific theme (e.g., petrophysical parameters, sonic properties).

3. Visualization and Interpretation

Users can generate different types of plots such as line plots, cross-plots, and histograms. There will be options for customizing plot styles and interpreting key results, depending on the theme.

4. Interactive Graphical User Interface

The GUI will integrate all sections, offering tabs or menus for data loading, processing, and visualization. It will provide users with a smooth workflow for analyzing well logs interactively.

1. GUI of Basic Petrophysics Code

Objective : To create a desktop application with a user-friendly interface that allows users to input, process, and visualize basic petrophysical data.

Features:

I. **User Interface**: Simple data input forms for petrophysical parameters (e.g., porosity, permeability, water saturation). Interactive data visualization (Multitrack, histograms, cross-plots) for petrophysical results. Data import/export capabilities (support for common file types like LAS, CSV, XLXS).

II. **Core Functionality**: Basic petrophysical properties calculations (e.g., Archie's equation, shale volume, effective porosity). Parameter sensitivity analysis (graphical sliders for parameter variation).

III. **Visualization**: Plotting petrophysical logs with depth (track-based visualization).Cross-plots between porosity, resistivity, and other derived parameters.

Technology Stack:

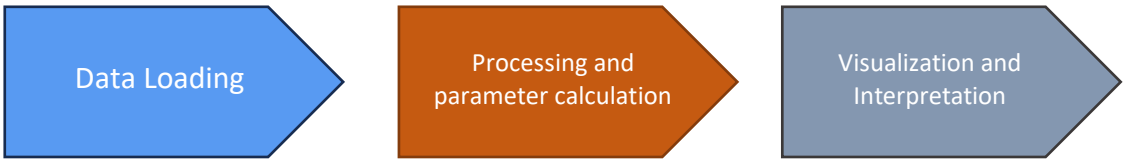
- **GUI**: PyQt, Tkinter (for standalone applications).
- **Backend**: Python-based petrophysical calculations modules and Visualization modules.

References:

- **Formation Evaluation :**
  - https://github.com/andymcdgeo
  - https://github.com/yohanesnuwara/formation-evaluation
- **Datasets :**
  - WAPIMS | Department of Mines, Industry Regulation and Safety (dmp.wa.gov.au)
  - You can use Gorgonichthys-1 well from your last year case study
- **GUI :**
  - https://www.pythonguis.com/pyqt5-tutorial/

2. Advanced Sonic Log Processing, Visualization, and Interpretation (GUI/Web)

Objective: To develop a platform (GUI or web-based) for sonic log processing, integrating algorithms for waveform analysis and calculation of petrophysical parameters.



Features:

I. **User Interface**:
   a. Interactive sonic log input with visual feedback.
   b. Tools for slowness analysis and waveform processing.

II. **Core Functionality**:
   a. Time-depth conversion, slowness-time coherence (STC), and semblance analysis.
   b. Rock mechanical properties calculation (e.g., dynamic Young's modulus, Poisson's ratio).
   c. Petrophysical properties calculation (e.g., porosity).

III. **Visualization**:
   a. Visualization of processed sonic data and its derivatives (e.g., shear and compressional velocities).
   b. Interactive 2D plots for sonic log.

IV. **Technology Stack**:
   a. **GUI**: PyQt, Streamlit, Taipy.
   b. **Backend**: Python with libraries like NumPy, SciPy, and custom signal processing algorithms.

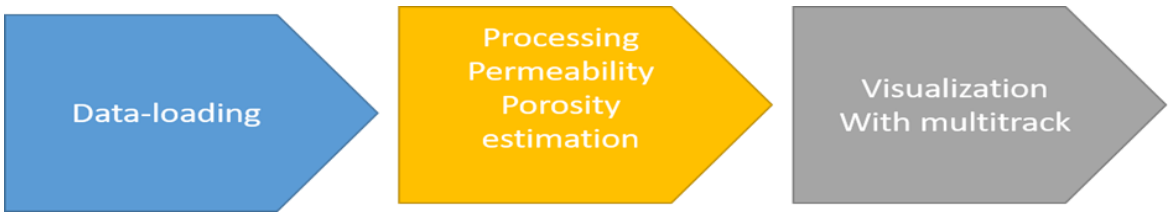
References:

- **Sonic log Processing :**
  - https://www.epa.gov/environmental-geophysics/sonic-borehole-logging
  - https://github.com/andymcdgeo/Petrophysics-Python-Series/blob/master/17%20-%20Loading%20DLIS%20Data.ipynb
- **Sonic Dataset (Dorado wells):**
  - WAPIMS | Department of Mines, Industry Regulation and Safety (dmp.wa.gov.au)
  - **https://nopims.dmp.wa.gov.au/Nopims/Search/Wells**
- **GUI :**
  - https://www.pythonguis.com/pyqt5-tutorial/
- **Web:**
  - https://docs.streamlit.io/develop/tutorials
  - https://docs.taipy.io/en/release-3.0/knowledge_base/tutorials/

3. NMR Log Visualization and Processing (GUI/Web)

Objective:

To build a GUI/web tool for processing Nuclear Magnetic Resonance (NMR) logs, focusing on fluid typing, pore size distribution, and permeability estimation.



Features:

I. **User Interface**: Input module for NMR T2 distributions. User control for parameters like cutoffs for fluid typing (free fluid, bound fluid).
II. **Core Functionality**: Automatic calculation of permeability using models like Timur-Coates and Schlumberger-Doll Research (SDR).Pore size distribution analysis and differentiation between movable and bound fluids.
III. **Visualization**: Interactive T2 distribution plots with graphical cutoffs. Multiple track display for raw data and interpreted outputs (free fluid, bound fluid, total porosity).
IV. **Technology Stack**:
    a. GUI: PyQt for desktop, Streamlit/Taipy for web.
    b. Backend: Python-based NMR processing and Visualization modules.

References:

- **NMR Processing :**
  - https://github.com/Philliec459/NMR-Echo-Train-Inversion-to-created-a-typical-NMR-log/tree/main
  - https://github.com/mauriciomafra-103/Petrophysics
- **NMR Dataset :**
  - https://www.sciencebase.gov/catalog/item/5f44292282ce4c3d1222da69
  - WAPIMS | Department of Mines, Industry Regulation and Safety (dmp.wa.gov.au)
- **GUI :**
  - https://www.pythonguis.com/pyqt5-tutorial/
- **Web:**
  - https://docs.streamlit.io/develop/tutorials
  - https://docs.taipy.io/en/release-3.0/knowledge_base/tutorials/

4. Image Log Visualization, Processing, and Interpretation (GUI/Web)

Objective:

To develop an application for the visualization and processing of image logs (e.g., FMI), providing tools for geological feature interpretation such as fractures, bedding planes, and faults.

Features:

I. **User Interface**: Data loading of FMI dataset.2D interactive displays of borehole images. Annotation tools for identifying geological features (fractures, faults).
II. **Core Functionality**: Image filtering and enhancement for better visualization of geological structures. Automated feature detection and classification. Dip angle and azimuth calculation and rose plot generation.
III. **Advanced Interpretation**: Image classification and Feature Extraction. Structural dip and azimuthal analysis.
IV. **Technology Stack**:
    a. GUI: PyQt for desktop, Streamlit/Taipy for web.
    b. Backend: Python-based NMR processing and Visualization modules.

References :

- **Image log data processing and interpretation**
  - https://doi.org/10.26599/TST.2019.9010020
  - https://github.com/ICWallis/borehole-image-analysis-with-python
- **Dataset:**
  - https://gdr.openei.org/submissions/1076
- **GUI :**
  - https://www.pythonguis.com/pyqt5-tutorial/
- **Web:**
  - https://docs.streamlit.io/develop/tutorials
  - https://docs.taipy.io/en/release-3.0/knowledge_base/tutorials/

You can review all the source files but need to bring your own idea to make it useful tool for academic and research purposes.

Marking of Product development: You will explain individual part as a team with selection of your own team leader. If there is more than 4 members, two persons need to explain the product. This section marking will be divided into three parts product design, usability, outcome and future use (4 x 5 = 15).

Product Development Presentation Guidelines

Each group is required to prepare a professional presentation. The presentation should be 15 minutes in length (each student ~4 minutes) and 5 minutes for QA. All group participants should take an active role in both preparing for the case study and presenting it.

Marking scheme for group presentations (15 marks)

Content: (50%)

- Is the group presentation well-organized and interesting?
- Has the group answered the case study questions and present them clearly?
- Have they given relevant concepts/theories/ideas and knowledge to the questions?

Presentation Style: (25%)

- Is the presentation lively and interesting?
- Is it structured effectively with a clear introduction, results, discussion, conclusion supported by evidence?
- Have the group shown initiative and creativity in the design of the presentation?
- How well do the presenters present themselves? Voice projection, eye contact, confident delivery, and interactions?
- How well prepared are the group to answer or pose questions that are relevant to the topic?

Group skills: (25%)

- Is the presentation clearly an integrated group effort as opposed to individual contributions?
- How well have they co-ordinated their activity and planned their presentation?

Marking of the presentation

Marking total -20	Content - 10	Presentation style - 5	Group skills - 5
Group-1			
Group-2			
Group-3			
Group-4			
Group-5			

Group-6			
Group-7			